CANADA COMMUNICABLE DISEASE REPORT

CCDR

40 years! (1975-2015)

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Inside this issue: Foodborne Illness

Gastroenteritis from foodborne illness is a common clinical and public health problem that occurs primarily from person-to-person contact and contaminated food, and may be linked to travel. In this issue, find out what we can learn from a provincial and a national tracking system for enteric outbreaks. Read the latest recommendations to prevent and treat travellers' diarrhea from CATMAT (the Committee to Advise on Tropical Medicine and Travel) and learn about a non-infectious foodborne illness that can come from a toxin in fish. Also, check out links to a recent systematic review on emergency and outpatient treatments of gastroenteritis and other resources.

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Public Health Agency of Canada. Food Safety. Find out about recent outbreaks, subscribe for updates, access fact sheets on common causes of food illnesses and check out who does what on food matters.
www.phac-aspc.gc.ca/fs-sa/index-eng.php

Upcoming conference

December 1-4, 2015: Epidemics5: Fifth International Conference on Infectious Disease Dynamics, Clearwater Beach, Florida
www.epidemics.elsevier.com/index.html

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Canada

Canada Communicable Disease Report

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Outbreak Report

An overview of foodborne outbreaks in Canada reported through Outbreak Summaries: 2008-2014

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Abstract

Background: Enteric outbreak investigation in Canada is performed at the local, provincial/territorial (P/T) and federal levels. Historically, routine surveillance of outbreaks did not occur in all jurisdictions and so the Public Health Agency of Canada, in partnership with P/T public health authorities, developed a secure, web-based Outbreak Summaries (OS) Reporting System to address this gap.

Objective: This analysis summarizes the foodborne outbreak investigations reported to the OS Reporting System between 2008 and 2014.

Methods: Finalised reports of investigations between 2008 and 2014 for all participating jurisdictions in Canada were extracted and descriptive analysis was carried out for foodborne outbreaks on etiological agent, severity of illness, outbreak duration, exposure setting and outbreak source.

Results: There were 115 reported foodborne outbreaks included in the analysis. This represents 11.2% of all outbreaks reported in the enteric module of the OS Reporting System between 2008 and 2014. *Salmonella* was the most commonly reported cause of foodborne outbreak (40.9%) and Enteritidis was the most common serotype reported. Foodborne outbreaks accounted for 3,301 illnesses, 225 hospitalizations and 30 deaths. Overall, 38.3% of foodborne outbreaks were reported to have occurred in a community and 32.2% were associated with a food service establishment. Most foodborne outbreak investigations (63.5%) reported a specific food associated with the outbreak, most frequently meat.

Conclusion: The OS Reporting System supports information sharing and collaboration among Canadian public health partners and offers an opportunity to obtain a national picture of foodborne outbreaks. This analysis has demonstrated the utility of the OS Reporting System data as an important and useful source of information to describe foodborne outbreak investigations in Canada.

Introduction

It is estimated that approximatively four million episodes of domestically acquired foodborne illness occur every year in Canada (1). Some of these illnesses will lead to hospitalizations and death. Recent estimates indicate that there are 11,600 hospitalizations and 238 deaths associated with domestically acquired foodborne illness every year in Canada (2). There are many reasons to investigate foodborne outbreak illness, in particular to identify and eliminate the source and prevent additional cases. Furthermore, results of an investigation may lead to recommendations for preventing future outbreaks (3).

Enteric outbreak investigation in Canada is performed at the local, provincial/territorial (P/T) and federal levels. In the past, routine surveillance of outbreaks did not occur in many Canadian jurisdictions and so, in response to this identified information gap and the recognized need for a Canadian outbreak surveillance system, the Public Health Agency of Canada (PHAC) partnered with P/T public health authorities in 2008 to implement the Outbreak Summaries (OS) Reporting System.

The OS Reporting System was designed as a national surveillance tool and all of its data is accessible to participating jurisdictions. Local, provincial/territorial and federal users can query and summarize data and generate reports on the results of any outbreak investigation that has been reported through the OS Reporting System. Information can be used to inform current outbreak investigations by providing historical information about outbreaks of certain pathogens to help generate potential hypotheses as to the etiology of current outbreaks, thus informing public health interventions. The Reporting System also supports information sharing and collaboration among a variety of Canadian public health partners.

The objective of this report is to summarize the foodborne outbreak investigations carried out by participating provinces between 2008 and 2014.

Methods

Data sources

The OS Reporting System is a secure, web-based application that can be used by local, P/T and federal public health professionals to summarize and share the results of outbreak investigations in a standard format. The Canadian Network for Public Health Intelligence (CNPHI) provides the platform on which the OS Reporting System resides. The system currently has two modules: one for enteric, foodborne and waterborne diseases and one for respiratory and vaccine-preventable diseases. Currently, six provinces (British Columbia, Manitoba, Ontario, Nova Scotia, Prince Edward Island and Newfoundland and Labrador) and the Centre for Food-borne, Environmental and Zoonotic Infectious Diseases (CFEZID) at PHAC have progressively implemented the enteric module of the OS Reporting System and routinely report outbreaks. Each participating jurisdiction inputs data into the OS Reporting System and each province has its own guidelines for outbreak reporting. PHAC reports multijurisdictional outbreaks led by the Agency.

Finalised reports for investigations between 2008 and 2014 for all participating jurisdictions in Canada were extracted on May 7, 2015 from the enteric, foodborne and waterborne diseases module in the OS Reporting System.

Data analysis

This report provides descriptive analysis of the etiological agent, severity of illness, outbreak duration, outbreak source and exposure setting. Community and institutional outbreaks were defined as per the text box below.

Definition of community and institutional outbreak for the Outbreak Summary Reporting System
Community outbreak: two or more unrelated cases with similar illness that can be epidemiologically linked to one another (i.e., associated by time and/or place and/or exposure). **Institutional outbreak:** three or more cases with similar illness that can be epidemiologically linked to one another (i.e., associated by exposure, within a four-day period in an institutional setting).

Data were reviewed for inconsistencies and redundancies prior to analysis. *Clostridium difficile* and vancomycin resistant *Enterococcus* (VRE) outbreaks were not analyzed as they are usually healthcare-associated infections and are typically managed quite differently than enteric outbreaks. Duplicate summaries where two (or more) different jurisdictional levels (e.g., PHAC and a province; a province and a health unit [HU] or Regional Health Authority [RHA]) reported on a jointly investigated outbreak were also removed from the analysis. In these cases, the report from the lead jurisdiction was retained for analysis and the other report(s) were excluded.

The year of investigation used in the analysis was derived from the date the outbreak investigation began. Descriptive analysis of the location of cases, principal etiologic agents, number of laboratory-confirmed and clinical cases, severity of illness and exposure/transmission settings involved were performed. The number

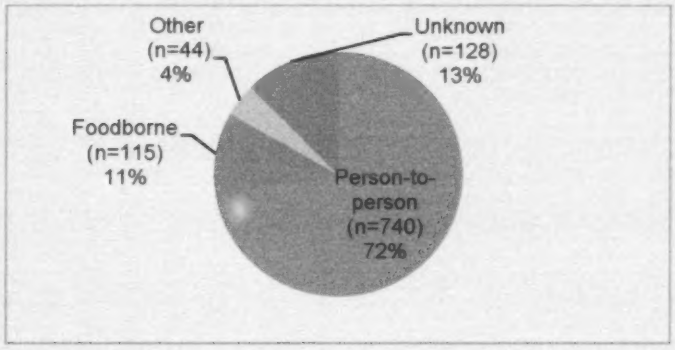
of cases, hospitalizations and deaths by etiologic agent was determined. Outbreak duration was also assessed and was calculated using the difference between the symptoms onset dates of the first and last case identified. Reports with missing values in either of these fields were excluded. More focused analyses of transmission settings by etiologic agent, as well as details about the sources identified in outbreaks with foodborne transmission were performed.

Analyses were carried out using *Microsoft Excel 2010*.

Results

There were 1,027 outbreaks entered into the OS Reporting System between 2008 and 2014. Of these, 115 were outbreaks related to a food source and were included in this analysis **(Figure 1).** These foodborne outbreaks represent 11.2% of all outbreaks reported in the OS Reporting System between 2008 and 2014, making them the second most common mode of transmission for enteric outbreaks reported, after person-to-person transmission. Other modes of transmission included environment-to-person, animal-to-person, waterborne and multiple modes of transmission.

Figure 1: Proportion of outbreak investigations reported to the Outbreak Summaries Reporting System by mode of transmission, 2008-2014 (n=1,027)



Foodborne outbreaks were the most commonly reported mode of transmission for PHAC-posted summaries (37/46 or 80.4%). British Columbia (BC) reported more than half of the foodborne outbreaks in the OS Reporting System (67/115 or 58.3%).

Etiologic agents

Table 1 presents the etiologic agents attributed to foodborne outbreaks reported in the OS Reporting System. Among the 115 foodborne outbreaks reported from 2008 to 2014, 106 outbreaks (92.2%) reported an etiologic agent. The majority (73%) of outbreaks were attributed to bacterial agents and viral etiology accounted for 14.8%. The most frequently reported etiologic agents were *Salmonella* (40.9%), *Escherichia* (14.8%) and norovirus (12.2%). A serotype was reported for 46 of the 47 *Salmonella* outbreaks. Enteritidis was the most common serotype reported and was responsible for 22 of the 47 *Salmonella* outbreaks (46.8%). All reported *Escherichia* outbreaks were caused by *E. coli* O157 VTEC.

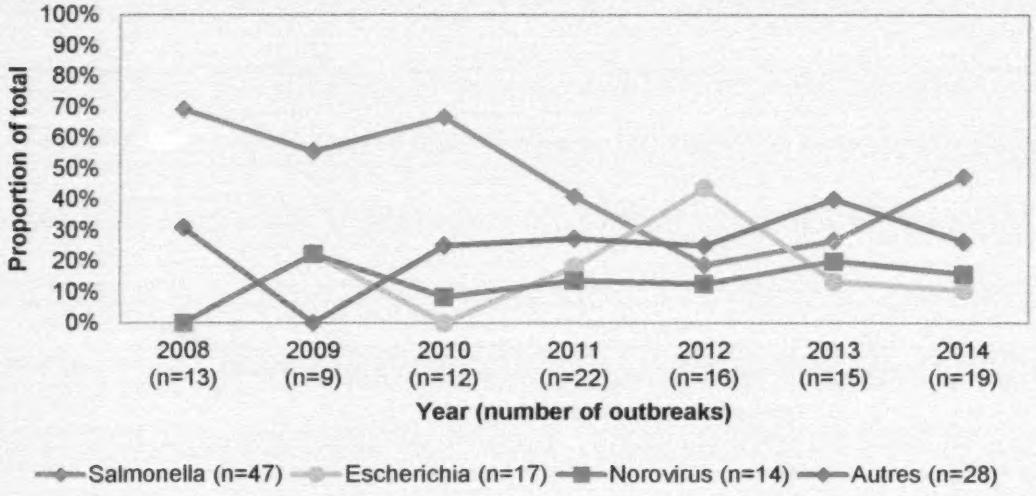
There were a total of 3,301 cases (2,261 lab-confirmed and 1,040 clinical) associated with the 115 foodborne outbreak investigations. The largest proportion (2,041/3,301 or 61.8%) of total cases was attributed to *Salmonella* infections and 87% of these cases were laboratory-confirmed. The second highest proportion (352/3,301 or 10.7%) of total cases was observed for norovirus, 92.9% of which were clinical cases.

Table 1: Number of foodborne outbreak investigations reported to the Outbreak Summaries (OS) Reporting System with the total number of cases by etiologic agent, 2008-2014 (n=115)

Etiologic agent	Outbreaks n (%)	Total cases n (%)	Cases	
			Lab-confirmed n (%)	Clinical n (%)
Bacterium	**84 (73)**	**2,588 (78.4)**	**2,076 (91.8)**	**512 (49.2)**
Salmonella	47 (40.9)	2,041 (61.8)	1,776 (78.5)	265 (25.5)
Escherichia	17 (14.8)	201 (6.1)	199 (8.8)	2 (0.2)
Clostridium botulinum	3 (2.6)	3 (0.1)	3 (0.1)	-
Clostridium perfringens	3 (2.6)	111 (3.4)	0 (0)	111 (10.7)
Listeria	3 (2.6)	67 (2)	67 (3)	-
Campylobacter	2 (1.7)	40 (1.2)	16 (0.7)	24 (2.3)
Staphylococcus	2 (1.7)	23 (0.7)	2 (0.1)	21 (2)
Bacillus	2 (1.7)	24 (0.7)	-	24 (2.3)
Shigella	1 (0.9)	14 (0.4)	9 (0.4)	5 (0.5)
Cronobacter	1 (0.9)	1 (0)	1 (0)	-
Other	1 (0.9)	16 (0.5)	3 (0.1)	13 (1.3)
Unknown	2 (1.7)	47 (1.4)	-	47 (4.5)
Virus	**17 (14.8)**	**422 (12.8)**	**52 (2.3)**	**370 (35.6)**
Norovirus	14 (12.2)	352 (10.7)	25 (1.1)	327 (31.4)
Hepatitis A	2 (1.7)	27 (0.8)	27 (1.2)	-
Unknown	1 (0.9)	43 (1.3)	-	43 (4.1)
Toxin / chemical poison	**6 (5.2)**	**88 (2.7)**	**12 (0.5)**	**76 (7.3)**
Shellfish poisoning	2 (1.7)	66 (2)	4 (0.2)	62 (6)
Histamine poisoning	2 (1.7)	8 (0.2)	8 (0.4)	-
Fiddlehead toxin	1 (0.9)	9 (0.3)	-	9 (0.9)
Unknown	1 (0.9)	5 (0.2)	-	5 (0.5)
Other	**4 (3.5)**	**128 (3.9)**	**121 (5.4)**	**7 (0.7)**
Cyclospora	3 (2.6)	121 (3.7)	121 (5.4)	-
Yeast / Fungi	1 (0.9)	7 (0.2)	-	7 (0.7)
Unknown	**4 (3.5)**	**75 (2.3)**	**0 (0)**	**75 (7.2)**
Grand total	**115 (100)**	**3,301 (100)**	**2,261 (100)**	**1,040 (100)**

Figure 2 shows the proportion of total foodborne outbreak investigations by year for the three most frequently reported pathogens among the 106 foodborne outbreaks with an etiologic agent reported. Over the study period, the overall proportions of *Salmonella* outbreaks decreased sharply in 2011 and 2012 and were mainly reported by BC and PHAC. During the same period, PHAC encountered a proportional increase in *E. coli*-related outbreaks (data not shown).

Figure 2: Proportion of total foodborne outbreak investigations reported to the Outbreak Summaries (OS) Reporting System by year by etiologic agents, 2008-2014 (n=106)



Severity of illness

Of the 3,301 total cases associated with foodborne outbreaks, 225 cases were hospitalized and 30 deaths were reported. The average number of cases, hospitalizations and deaths associated with each pathogen varied greatly. Known etiologic agents that caused the greatest number of cases per outbreak were *Salmonella*, *Cyclospora*, *Clostridium perfringens* and shellfish poisoning with an average of 43, 40, 37 and 33 cases per outbreak respectively.

Data on severity of illness, hospitalization and death is summarized in **Table 2.** Infections due to *Salmonella* and *E. coli* together accounted for the majority of hospitalizations (106 and 84 respectively), but the hospitalization proportion differs greatly between these two pathogens. *Salmonella* had an average hospitalization proportion of 12% while *E.coli* had an average of 41.8%. *Clostridium botulinum*, *Listeria* and histamine poisoning had the highest hospitalization proportions with 100%, 90%, and 75% respectively.

Listeria was the most common cause of outbreak-related deaths, accounting for 73.3% of total deaths (22/30). The case fatality ratio for *Listeria* was 32.8% among outbreak-related cases. All 22 *Listeria*-related-deaths reported in the OS Reporting System occurred during the same outbreak and involved immune-compromised and elderly individuals, most of whom were in hospitals or long term care facilities during their exposure period.

Table 2: Number of foodborne outbreaks reported to the Outbreak Summaries (OS) Reporting System with the total number of cases, hospitalizations and deaths by etiologic agent, 2008-2014 (n=115)

Etiologic agent	Average no. cases by outbreak Avg. (range)	Total cases n (%)	Hosp. n (%[1])	Deaths n (%[1])
Bacterium	**30.8 (1-1029)**	**2,588 (78.4)**	**205 (15)**	**30 (1.2)**
Salmonella	43.4 (1-1029)	2,041 (61.8)	106 (12)	4 (0.2)
Escherichia	11.8 (1-30)	201 (6.1)	84 (41.8)	3 (1.5)
Campylobacter	20 (10-30)	40 (1.2)	-	-
Clostridium botulinum	1.0 (1-1)	3 (0.1)	3 (100)	1 (50)
Clostridium perfringens	37.0 (28-54)	111 (3.4)	-	-
Listeria	22.3 (5-57)	67 (2)	9 (90)	22 (32.8)
Shigella	14.0 (14-14)	14 (0.4)	2 (14.3)	-
Staphylococcus	11.5 (7-16)	23 (0.7)	1 (4.3)	-
Bacillus	12.0 (11-13)	24 (0.7)	-	-
Cronobacter	1.0 (1-1)	1 (0)	-	-
Other	16.0 (16-16)	16 (0.5)	-	-
Unknown	23.5 (4-43)	47 (1.4)	-	-
Virus	**24.8 (6-99)**	**422 (12.8)**	**11 (2.8)**	-
Norovirus	25.1 (7-99)	352 (10.7)	1 (0.3)	-
Hepatitis A	13.5 (6-21)	27 (0.8)	10 (47.6)	-
Unknown	43.0 (43-43)	43 (1.3)	-	-
Toxin / chemical poison	**14.7 (2-62)**	**88 (2.7)**	**7 (26.9)**	-
Histamine poisoning	4.0 (2-6)	8 (0.2)	6 (75)	-
Shellfish poisoning	33.0 (4-62)	66 (2)	1 (25)	-
Fiddlehead toxin	9.0 (9-9)	9 (0.3)	-	-
Unknown	5.0 (5-5)	5 (0.2)	-	-
Other	**32.0 (7-85)**	**128 (3.9)**	**2 (1.6)**	-
Cyclospora	40.3 (11-85)	121 (3.7)	2 (1.7)	-
Yeast / Fungi	7.0 (7-7)	7 (0.2)	-	-
Unknown	**18.8 (6-41)**	**75 (2.3)**	-	-
Grand total	**28.7 (1-1029)**	**3,301 (100)**	**225 (11.4)**	**30 (1)**

[1] Data shown are the total number by etiologic agent with the proportion of total cases for respective etiologic agent in parenthesis. (Note: Outbreaks with missing data for hospitalization or death were excluded from the denominator.) The information about the number of hospitalizations is missing for 10/47 *Salmonella* outbreak reports; 1/14 norovirus reports and one each of the *Listeria*, *Cronobacter*, Hepatitis A and Shellfish poisoning outbreak reports. The number of deaths is missing for 8/47 *Salmonella* outbreak reports, 2/14 norovirus reports as well as for one each of *Clostridium botulinum*, *Bacillus cereus* and Hepatitis A outbreaks.

Duration

Data for symptoms onset date for both the earliest or the most recent case was available for 94 of the 115 (81.7%) foodborne outbreaks reported in the OS Reporting System. Outbreak duration ranged from less than one day to 1,689 days, with the median and mean being eight days and 52.7 days, respectively. The outbreak with 1,689 days duration was attributed to a S. Enteritidis outbreak in one province linked to eggs and was associated with 1,029 laboratory-confirmed cases.

Exposure

Overall, 44 (38.3%) foodborne outbreaks and 60.8% of total foodborne outbreak-related cases (n=2,006) were reported to have occurred in a community setting, while 37 outbreaks (32.2%) and 18.3% of total cases (n=604) were associated with a food service establishment. The etiologic agent was laboratory-confirmed in the majority of foodborne outbreaks (96/115 or 83.5%).

Table 3: Number of foodborne outbreak investigations with laboratory-confirmed etiologic agent reported to the Outbreak Summaries (OS) Reporting System by exposure/transmission setting, 2008-2014

Exposure/transmission setting	Number of outbreaks n (%)	Number of outbreaks with lab-confirmed etiologic agent n (%)	Total cases n (%)
Community	44 (38.3)	44 (38.3)	2,006 (60.8)
Food service establishment	37 (32.2)	26 (22.6)	604 (18.3)
Private function	14 (12.2)	10 (8.7)	24 (0.7)
More than one setting	5 (4.3)	4 (3.5)	145 (4.4)
Institutional - residential	4 (3.5)	3 (2.6)	11 (0.3)
Institutional - non-residential	4 (3.5)	2 (1.7)	1 (0)
Travel-related - outside Canada	1 (0.9)	1 (0.9)	33 (1)
Other setting	2 (1.7)	2 (1.7)	411 (12.5)
Unknown	4 (3.5)	4 (3.5)	66 (2)
Grand total	**115 (100)**	**96 (83.5)**	**3,301 (100)**

Most investigations (73/115 or 63.5%) reported a specific food associated with the outbreak (data not shown). Meat was the most commonly reported source (26%), followed by eggs (15.1%) and vegetables (13.7 %). Among the 47 foodborne *Salmonella* outbreaks, the foods associated with the outbreak were identified in 28 outbreaks (59.6%) and were mainly eggs (39.3%) and meat (28.6%). Twelve of the17 *E. coli* outbreaks (70.6%) had a food source identified and these were mainly related to meat products (50%). The remaining were related to raw vegetables, nuts or seeds, dairy product and fruit. Finally, ten of the14 norovirus outbreaks were associated with a specific food item, among which seafood, fruits, vegetables and mixed or other food were identified. One norovirus outbreak identified as foodborne was associated with an ill food handler.

Table 4: Number and proportion of food items associated with the outbreak by etiologic agents, 2008-2014

Food items associated with the outbreak	Escherichia n (%)	Norovirus n (%)	Salmonella n (%)	Other n (%)	Unknown n (%)	Total n (%)
Meat	6 (50)	-	8 (28.6)	5 (27.8)	-	19 (26)
Eggs	-	-	11 (39.3)	-	-	11 (15.1)
Vegetables	2 (16.7)	1 (10)	4 (14.3)	2 (11.1)	1 (20)	10 (13.7)
Seafood	-	3 (30)	-	5 (27.8)	1 (20)	9 (12.3)
Fruit	1 (8.3)	2 (20)	3 (10.7)	1 (5.6)	-	7 (9.6)
Nuts/Seeds	2 (16.7)	-	1 (3.6)	-	-	3 (4.1)
Dairy products	1 (8.3)	-	-	-	-	1 (1.4)
Mixed or other	-	4 (40)	1 (3.6)	5 (27.8)	3 (60)	13 (17.8)
Grand total	**12 (100)**	**10 (100)**	**28 (100)**	**18 (100)**	**5 (100)**	**73 (100)**

Discussion

This is the first national report published on foodborne outbreaks using data from the OS Reporting System. One hundred fifteen (11.2%) of the enteric outbreaks reported in the OS Reporting System were foodborne outbreaks, *Salmonella* (40.9%), *Escherichia* (14.8%) and norovirus (12.2%) were the most common etiologic agents. Surveillance data from the National Enteric Surveillance Program (NESP) also reflect the importance of *Salmonella* as an etiologic agent of enteric illness in Canada given that *Salmonella* was the most common pathogen (40.3%) reported to the NESP in 2013 (4). Of note, the NESP provides a wider picture as it also includes sporadic and travel-acquired cases.

The total number of locally-acquired, sporadic foodborne illnesses in Canada has also been estimated. The five most frequent pathogens are: norovirus (65.1%), *Clostridium perfringens* (11%), *Campylobacter* spp. (8.4%), non-typhoidal *Salmonella* spp., (5.1%) and *Bacillus cereus* (2.3%) (1). It is interesting to note the differences between the top five pathogens identified in this study, and the most commonly identified pathogens in the OS Reporting System. The under diagnosis and lack of laboratory confirmation for some infections like *Campylobacter* and toxins, as well as under-reporting and variable investigation practices for these pathogens in Canada may explain why these pathogens are not ranked as high in the OS Reporting System. Among foodborne outbreaks in the US in 2013 with a known etiologic agent, norovirus was the most common pathogen at 44.8%, followed by *Salmonella* (32.3%) and STEC *E. coli* (3.9%) (4). The relative frequency of these pathogens among foodborne outbreaks differs from Canada, especially for norovirus. This could be explained in part by differences in reporting and investigation practices between the two countries.

The proportion of hospitalized cases of *Salmonella* (12%) and norovirus (0.3%) in the OS Reporting System were relatively similar to those observed in the US (17.5% and 0.7%, respectively) (5). The proportion of hospitalized cases was higher for *E. coli* than *Salmonella* both in Canada (41.8%) and US (33.3%). A comparison between case fatality data in the OS Reporting System with US data could not be made due to the small number of deaths observed. The majority of all foodborne outbreaks involved laboratory-confirmed etiologic agents; however, the ratio of lab-confirmed to clinical cases was much higher for bacterial outbreaks than for viral or toxin/chemical related outbreaks. This is likely a result of differences in symptom presentation and severity between bacterial outbreaks versus other outbreaks and the subsequent likelihood if getting tested. It may also be related to the effectiveness of viral versus bacterial testing methods in identifying a pathogen.

Most foodborne outbreaks occurred in the community or involved a food service establishment. The most commonly reported outbreak source was meat (19/73 or 16.5%) followed by eggs (11/73 or 15.1%) and vegetables (10/73 or 13.7 %). Interestingly, the US reported a slightly lower proportion of outbreaks with an identified source (46%, compared to 63.5% in the OS Reporting System), with fish as the most commonly identified commodity at 23.8%, followed closely by mollusk (11%), chicken and dairy (10% each) (5).

The strength of the OS Reporting System is that it provides a source of data to monitor the occurrence of and trends in enteric, foodborne and waterborne disease outbreaks at the national level. It provides F/P/T partners with a system that allows them to collect, query and summarize outbreak information in a systematic and standardized manner. These data have been used to support hypothesis generation in outbreak investigations led by PHAC and by participating jurisdictions for their own internal reporting and outbreak investigations. Data has also informed internal reports and projects conducted within PHAC and the Canadian Food Inspection Agency (CFIA).

Several limitations associated with the analyses of OS Reporting System data have been identified. Reporting criteria and timelines are set by each participating province and can vary greatly which may potentially affect data completeness. Some jurisdictions that have made reporting of outbreaks mandatory have identified timeframes for reporting, while other partners have not, nor have such guidelines been set nationally. Reporting practices have also changed over time as provinces adapt to using the OS Reporting System in their jurisdictions which may have resulted in a change in the types of outbreaks that are reported. Further, as there are only six provinces as well as PHAC that report outbreaks through the OS Reporting System, the results of the current analysis are likely not nationally representative. Finally, issues with data quality and consistency have been identified. For example, interpretation of investigation start and end dates varies between jurisdictions and missing data for these variables, as well as for many other non-mandatory fields, limits the conclusions that can be drawn about these aspects of outbreaks investigations.

Future efforts will focus on continuing to enhance national representativeness by enrolling additional provinces and territories in the OS Reporting System. Based on the above limitations, discussion will continue among partners to increase the data quality and consistency of the system. Finally, existing data fields are undergoing review and additional variables are anticipated that will improve the description and characterization of outbreaks.

Conclusion

This analysis is the first national-level summary of outbreaks reported through the OS Reporting System. This system supports information sharing and collaboration among Canadian public health partners and offers the opportunity to obtain a national picture of foodborne outbreaks in Canada. As more jurisdictions join, the data will become more robust and will increase our national capacity to monitor trends and inform policy development and public health planning.

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Conflict of interest

None.

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Outbreak Report

Enteric outbreak surveillance in British Columbia, 2009-2013

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Abstract

Background: Understanding enteric disease outbreak sources, burden of illness, mode of transmission and use of interventions informs planning, policy development and prevention programs.

Objective: To describe trends in enteric disease outbreaks investigated in British Columbia (BC) between 2009 and 2013.

Methods: An analysis was conducted of enteric disease outbreaks that had been entered into a national, secure web-enabled outbreak reporting system using the Canadian Network for Public Health Intelligence (CNPHI) and investigated in BC between January 1, 2009 and December 31, 2013. The data included information on pathogen, number of cases, hospitalizations, deaths, setting, mode of transmission, source, factors that contributed to the outbreak and interventions. Residential facility-based viral outbreaks and outbreaks associated with international travel were excluded.

Results: There were 104 outbreaks investigated in BC between 2009 and 2013. Ninety-three were reported by BC organizations and 11 were national outbreak investigations reported by the Public Health Agency of Canada (PHAC). There was an average of 21 outbreaks per year. Overall, the annual rate of foodborne outbreaks in BC was 2.8 per one million population. Seventy-nine (76%) outbreaks had a pathogen identified, most commonly norovirus, *Salmonella* and *E. coli*. There was a total of 108 hospitalizations (3.8% of all cases) and two deaths (0.1% of all cases); one caused by botulism, the other by *E. coli* O157. Food service establishments were the most common setting (33.7%), followed by the community (24.0%) and private functions (12.5%). The food types most often reported were fruits and vegetables, meat and seafood. The data showed a pathogen-food source combination between *Salmonella* and eggs.

Conclusion: This is the first publication summarizing trends in enteric disease outbreaks in BC including assessing sources, burden and interventions. Ongoing reporting and analysis of outbreak data in BC will allow for improved assessment of trends in sources and pathogens over time and further understanding of the effectiveness of interventions associated with outbreaks.

Introduction

There are an estimated 552,209 cases of domestically-acquired foodborne illness in British Columbia (BC) each year (*unpublished data, BC Centre for Disease Control and Public Health Agency of Canada, 2014*). Although only a small proportion of these cases are associated with confirmed outbreaks (0.8-2.5% of all cases) (1), outbreaks are a valuable source of information on sources of illness, burden of illness, modes of transmission and interventions (2). This information can be used by public health authorities, policy-makers,

food safety professionals and the food industry to set priorities and to plan and implement prevention programs. The province of BC implemented enteric disease outbreak surveillance in 2008 to describe trends, improve understanding, conduct source attribution and evaluate interventions and resource use.

The objective of this study is to describe trends in enteric disease outbreaks investigated in BC between 2009 and 2013 as well as to conduct source attribution and describe interventions.

Methods

Gastroenteritis epidemics are reportable in BC (3). In August 2008, a national, secure web-enabled outbreak reporting system, using the Canadian Network for Public Health Intelligence (CNPHI), was launched in BC and enteric disease outbreaks are entered by all local health authorities and by the BC Centre for Disease Control (BCCDC) into this system. This CNPHI system is also used by other jurisdictions across Canada.

A gastrointestinal outbreak in the system is defined as one of two types: *Community Outbreak:* two or more unrelated cases with similar illness that can be epidemiologically linked to one another, i.e., associated by time and/or place and/or exposure and *Institution Outbreak:* three or more cases with similar illness that can be epidemiologically linked to one another, i.e., associated by exposure within a four-day period in an institutional setting.

All data is entered electronically (retrospectively) and includes information on pathogen, number of cases, hospitalizations, deaths, setting, mode of transmission, source, factors that contributed to the outbreak and interventions. Each local health authority is responsible for entering outbreaks investigated within their jurisdiction into the system. The BCCDC enters multi-regional outbreaks and the Public Health Agency of Canada (PHAC) enters multi-provincial/territorial outbreaks.

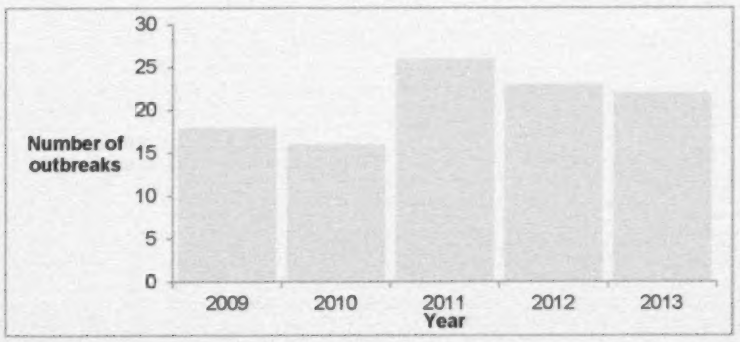
This report includes data on reported enteric disease outbreak investigations initiated between 2009 and 2013 in BC. National outbreaks (reported by PHAC) that involved cases residing in BC were also included. Residential facility-based viral outbreaks and outbreaks associated with international travel were excluded.

Data were extracted on March 6, 2014 and for national outbreaks on June 5, 2014. Comparison between outbreaks reported as foodborne and person-to-person transmission was conducted for setting, contributing factors and interventions. Source attribution was conducted using only outbreaks reported as foodborne. Outbreaks were associated with food handlers if a pathogen was identified in a food handler or an infected food handler was identified. Year and month of the outbreak investigation were based on the date the investigation started. Outbreak duration was calculated using the earliest and last symptom onset dates reported.

Results

There were 104 outbreaks investigated between 2009 and 2013. Ninety-three were reported by BC organizations and 11 were reported by PHAC. There was an average of 21 and median of 22 outbreaks investigated each year, with a range of 16-26 outbreaks per year (**Figure 1**). There was an approximately 40% increase in outbreaks investigated in 2011 which was sustained in 2012 and 2013. The annual rate of foodborne outbreaks in BC was 2.8 outbreaks per one million population.

Figure 1: Number of enteric disease outbreaks reported by year, British Columbia (N=104)



There were 50 (48.1%) bacterial and 42 (40.4%) viral outbreaks reported. Seventy-nine (76.0%) of all outbreaks had a lab-confirmed pathogen identified (**Table 1**). The pathogens most commonly reported were norovirus, *Salmonella* and *E. coli* (**Table 2**). Enteritidis was the most commonly reported serotype of *Salmonella* (n=13, 50.0%) and all *E. coli* outbreaks were caused by *E. coli* O157.

There were a total of 2,134 outbreak-related (clinical and lab-confirmed) cases (**Table 1**). The majority were clinically identified (76.4%) and outbreaks caused by viral pathogens had the largest number and proportion of clinical cases. Of all cases, 108 (5.1%) resulted in hospitalizations. Outbreaks caused by bacteria led to the largest number and proportion of hospitalizations (81, 75.0%). Of the hospitalizations, the pathogens with the largest number and proportion were *Salmonella* (38, 35.2%), *E. coli* (37, 34.3%) and norovirus (10, 9.3%). Two deaths were due to a bacterial infection (**Table 1**), one by botulism and the other by *E. coli* O157.

There was an average of 20.3 cases per outbreak. Outbreaks caused by viral pathogens had the largest average number of cases (29.0) and outbreaks caused by yeast/fungi had the smallest (7.0). Outbreak duration had a median of four days. Outbreaks caused by bacterial and parasitic outbreaks had a notably longer duration, 11 and 16 days respectively (**Table 1**).

Table 1: Characteristics of enteric disease outbreak investigations by pathogen type, British Columbia, 2009-2013

Characteristic	Bacterial (n=50)	Viral (n=42)	Parasitic (n=2)	Unknown (n=4)	Toxin/ chemical (n=5)	Yeast/ fungi (n=1)	Total (n=104)
Number (%) of lab-confirmed outbreaks	49 (98.0%)	23 (54.8%)	2 (100%)	0 (0%)	5 (100%)	0 (0%)	79 (76.0%)
Total number of lab-confirmed cases	398	80	12	0	12	0	502
Total number of clinical cases	351	1138	16	45	75	7	1632
Average number of cases[1]/outbreak	14.9	29.0	22.0	11.3	15.4	7.0	20.3
Total number and % of hospitalizations	81 (75.0%)	20 (25.0%)	0	0	7	0	108
Total number and % of deaths	2 (100%)	0	0	0	0	0	2
Median duration in days of outbreak based on dates of onset (range)	11 (0-234)	4 (0-137)	16	1 (0-2)	0 (0-11)	0	4 (0-234)

[1]Includes both laboratory confirmed and clinical.

Table 2: Enteric disease outbreaks by pathogen, British Columbia, 2009-2013

Pathogen	Number (%)
Norovirus	38 (36.5%)
Salmonella	26 (25%)
Escherichia coli	12 (11.5%)
Clostridium botulinum	3 (2.9%)
Campylobacter	2 (1.9%)
Hepatitis A	2 (1.9%)
Histamine poisoning	2 (1.9%)
Shellfish poisoning[1]	2 (1.9%)
Staphylococcus	2 (1.9%)
Other[2]	7 (6.7%)
Unknown[3]	8 (7.7%)
Total	104

[1] Paralytic Shellfish Poisoning (1), Diarrhetic Shellfish Poisoning (1).
[2] *Aeromonas* (1), toxin/chemical (1), *Cryptosporidium* (1), *Cyclospora* (1), *Shigella* (1), *Clostridium perfrigens* (1), *Clostridium difficile* (1).
[3] This number includes one outbreak reported as bacterial-unknown, two viral-unknown and one yeast/fungi unknown as well as four where the pathogen causing the outbreak was unknown. In **Table 2**, four of these are categorized into their higher-level groups.

Foodborne exposure was the most common mode of transmission (59.6%) (**Table 3**). Of the 62 foodborne outbreaks, 40 (64.5%) were caused by bacteria. The most common cause was *Salmonella* (n=22). Of the person-to-person outbreaks, 22 (95.7%) were caused by viruses, all norovirus.

Food service establishments were the most common outbreak setting (33.7%), followed by community (24.0%) and private functions (12.5%) (**Table 3**). Outbreaks at food service establishments were caused by food as well as person-to-person transmission. Of the eight person-to-person outbreaks in food service establishments, only two documented ill food handlers as the source. Person-to-person outbreaks had a higher proportion of outbreaks associated with facilities (e.g., hospitals, schools, hotels) (**Table 3**).

Table 3: Enteric disease outbreaks by mode of transmission and setting, British Columbia, 2009-2013

Outbreak setting	Foodborne	Person-to-person	Unknown	Other[1]	Waterborne	Total
Food service establishment	24 (38.7%)	8 (34.8%)	1 (8.3%)	2 (25%)	0 (0%)	35 (33.7%)
Community	17 (27.4%)	2 (9%)	5 (41.7%)	1 (12.5%)	0 (0%)	25 (24%)
Private function	10 (16.1%)	3 (13%)	0 (0%)	0 (0%)	0 (0%)	13 (12.5%)
Institutional[2]	5 (8.1%)	4 (17.4%)	1(8.3%)	1 (12.5%)	0 (0%)	11 (10.6%)
Non-Institutional facility[3]	0 (0%)	3 (13.0%)	1(8.3%)	0 (0%)	0 (0%)	4 (3.8%)
Recreational facility	0 (0%)	2 (8.7%)	0 (0%)	1 (12.5%)	0 (0%)	3 (2.9%)
More than one setting	3 (4.8%)	1 (4.3%)	1(8.3%)	1 (12.5%)	0 (0%)	6 (5.8%)
Other	2 (3.2%)	0 (0%)	2 (16.6%)	2 (25%)	0 (0%)	6 (5.8%)
Unknown	1 (1.6%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)
Total	62 (59.6%)	23 (22.1%)	11 (10.6%)	8 (7.7%)	0 (0%)	104

[1] Includes animal-to-person, environment-to-person, other, multiple
[2] Includes both non-residential and residential.
[3] Examples include: schools, hotels, hospitals.

A food source was identified in 45 (72.6%) of the foodborne outbreaks (**Table 4**) and were most often reported to be fruits and vegetables, meat and seafood. Fruits and vegetables, which included fresh, frozen

and canned fruits and vegetables, were associated with the largest number of different pathogens (n=5). Among the 14 outbreaks caused by *Salmonella*, where a source was identified, eggs were the main cause in five of the reported outbreaks (35.7%). The only dairy-related outbreak was caused by unpasteurized cheese. Norovirus caused ten foodborne outbreaks and a source was identified in nine of them. Norovirus outbreaks were caused by seafood, mixed foods, fruit and vegetables. In eight of the outbreaks with a source and the single outbreak without a source, an infected food handler was identified as the contributing factor (data not shown).

Table 4: Foodborne outbreaks by pathogen and source, British Columbia, 2009-2013

Food Type	*Clostridium botulinum*	*Escherichia coli*	Hepatitis A	Noro-virus	*Salmonella*	Shellfish poisoning [1]	*Staphylo-coccus*	Other[2]	Un-known	Total
Fruit and vegetables	1	1	1 (4)	3	3	0	0	0	1	10
Meat[3]	0	4	0	0	4 (5)	0	1	0	0	9
Seafood	1	0	0	2 (6)	0	4 (7)	0	0	1	8
Mixed Foods	0	0	0	3	0	0	1	1	2	7
Eggs	0	0	0	0	5 (8)	0	0	0	0	5
Dairy Products	0	1	0	0	0	0	0	0	0	1
Sauces/ Condiments	1	0	0	0	0	0	0	0	0	1
Unknown	0	2	1	2	10	0	0	4	2	21
Total	3	8	2	10	22	4	2	5	6	62

[1] PSP (1), DSP (1), Histamine (2)
[2] *Aeromonas* (1) *Campylobacter* (1), *C. perfringens* (1), *Cyclospora* (1), *Shigella* (1)
[3] Included beef (2) chicken (3), deli meat (1), turkey (1) veal liver (1) and haggis (1)

Foods which led to the largest number of cases were caused by eggs (n=196), mixed foods (n=168) and seafood (n=139). These foods accounted for 45.5% of all foodborne outbreak cases.

The most common contributing factors among foodborne outbreaks were associated with the process of food production (e.g., critical control point failures, inadequate cooking, cross contamination). Among person-to-person outbreaks, common contributing factors were related to exposure to another ill person, another case or a contaminated environment (**Table 5**).

Table 5: Contributing factors for foodborne and person-to-person outbreaks, British Columbia, 2009-2013

Contributing Factor	Foodborne (N=62)	Person to person (N=23)
Critical control point failure	17 (27.4%)	1 (4.3%)
Cross contamination	11 (17.7%)	3 (13%)
Improper temperature (e.g., cooling or hot holding)	12 (19.4%)	0
Inadequate re-heating	1 (1.6%)	0
Infected food handler	11 (17.7%)	2 (8.7%)
Inadequate cooking	12 (19.4%)	0
Poor hygiene	8 (12.9%)	6 (26.1%)
Personal caregiver contact	0	2 (8.7%)
Exposure to confirmed/probable cases	1 (1.6%)	7 (30.4%)
Inadequate environmental sanitation	5 (8%)	3 (13%)

The most common interventions used to control outbreaks were education, sanitizing the facility and cohorting cases/staff (**Table 6**). For person-to-person outbreaks education and sanitizing the facility were the most common interventions. Foodborne outbreaks most often reported a food recall and closing a facility as an intervention, compared to person-to-person outbreaks which reported restricting admissions/transfers or visitors and cohorting cases or staff. Seven foodborne outbreaks reported a policy change as an intervention. A press release was issued for ten outbreaks; nine foodborne and one person-to-person

outbreak. Education was the most common intervention used across all food sources. Recalls were used most often for meat (5), seafood (2) and fruit (2). Sanitizing the facility was performed in outbreaks caused by eight different food sources.

Table 6: Interventions used to control foodborne and person-to-person outbreaks, British Columbia, 2009-2013

Intervention	Foodborne (N=62)	Person-to-person (N=23)	Other (N=20)	Total
Education	36 (59%)	15 (24.6%)	10 (16.4%)	61
Sanitize facility	13 (40.6%)	9 (28.1%)	10 (31.3%)	32
Cohort cases or staff	2 (11.8%)	8 (47.1%)	7 (41.2%)	17
Exclude staff	7 (46.7%)	5 (33.3%)	3 (20%)	15
Recall	12 (100%)	0	0	12
Restrict facility admissions/transfers and/or visitors	2 (18.2%)	7 (63.6%)	2 (18.2%)	11
Press release	9 (90%)	1 (10%)	0	10
Close facility	6 (66.7%)	1 (11.1%)	2 (22.2%)	9
Policy change	7 (100%)	0	0	7
Immunize susceptible contacts	1 (100%)	0	0	1
Boil water advisory	0	0	0	0

Discussion

Over the five year time period, a notable number of reported enteric disease outbreaks caused a significant burden of illness in BC. An increase in the number of outbreaks reported between 2011 and 2013 likely reflects efforts to improve reporting of outbreaks. This also included a decision to stop reporting viral outbreaks in residential-facilities as of July 2011, which may have improved the reporting of outbreaks caused by other modes of transmission settings and sources. This exclusion does limit the ability to count the total number of enteric disease outbreaks caused by all sources, pathogens and settings at a provincial level.

Norovirus was the most common outbreak cause followed by *Salmonella*. Both of these are in the top five pathogens causing domestically-acquired foodborne illness in BC (*unpublished data. BC Centre for Disease Control and Public Health Agency of Canada, 2014*). These are also the most common pathogens that cause outbreaks in the US (2). Viral outbreaks caused the largest number of cases and bacterial outbreaks were responsible for more hospitalizations and deaths. Bacterial, parasitic and toxin/chemical outbreaks were more frequently lab-confirmed compared to viral outbreaks. This is likely because viral outbreaks may be investigated and managed without laboratory diagnosis, are self-limited and not associated with severe presentation.

The proportion of hospitalized (3.8%) is comparable with the US (3.4%) and lower than European data (13.8%) (2,10). The case-fatality rate (0.1%) is lower than the US (0.7%) but slightly higher than European data (0.03%) (2,10). In the US and BC, *Salmonella*, *E. coli* and norovirus caused the largest number and proportion of hospitalizations. These similarities may be due to the fact that in both countries more severe cases are more likely to be tested and lab-confirmed. The difference between the proportion of hospitalization in Europe may be impacted by the more severe diseases included such as toxoplasmosis and tularaemia. The difference in proportion of deaths between BC, the US and Europe may be due to small numbers.

The annual rate of foodborne outbreaks in BC (2.8 per one million population) is lower than the US rate of 4.8 per one million population (2). This may be due to different systems and methods of reporting.

Food service establishments were the most common setting for all outbreaks (34%) in BC. Among *Salmonella* outbreaks in BC, food service establishments were still the most common setting and made up

47.6% of outbreaks. This is similar to the US where food prepared in a restaurant or deli was also the most common setting for foodborne outbreaks with a single place of food preparation, although these accounted for a larger proportion (68%). New Zealand reported commercial food operations were the second most common location for *Salmonella* outbreaks (31%) while the home was the most common setting reported (2,9).

The majority of outbreaks were foodborne (59.6%) with *Salmonella* causing the largest proportion of foodborne outbreaks (35.8%). Of the *Salmonella* outbreaks, 84.6% were foodborne which is higher than New Zealand (63%) (9). *Salmonella* was also the most common cause of foodborne outbreaks reported in Europe (10).

The source of exposure was identified for 72.6% of foodborne outbreaks. This is higher than what was previously reported for BC and other jurisdictions (11,12). This may be because outbreaks with an identified source are more likely to be reported. Produce, meat and seafood were the most common foods (16%, 15% and 13% respectively). Produce caused more outbreaks than meat, eggs and dairy products. US analysis identified meat products as the top source of foodborne outbreaks, with a change in more recent years to a larger proportion of outbreaks caused by leafy vegetables (2). Produce-associated outbreaks have increased in North America (13,14,15). Monitoring these trends through outbreak data will enable re-prioritization of prevention efforts.

These data show an association between *Salmonella* and eggs. During this time period, BC investigated a large, protracted outbreak of *Salmonella* Enteritidis (SE) associated with eggs (8). SE outbreaks were still most commonly caused by eggs in the US, but a decrease in *Salmonella* outbreaks caused by eggs over time was noted (2). European data demonstrated that eggs and egg products were the most important food vehicles for *Salmonella* (10). Food-specific attribution has been done previously in Canada twice using expert elicitation and once using outbreak data (16,17,18). All three identified poultry meat as the most likely source of *Salmonella* infections. Eggs were identified as the second most common source among the expert elicitations. The expert elicitations also demonstrate a large proportion of enteric bacterial infections are attributed to produce which is comparable with the findings of this study (16,17).

Outbreaks are a validated source attribution data. Strengths of outbreak data include: a clear link between the pathogen and food, availability of data over time and the inclusion of a wide-variety of food items that may not be represented using other methods (9). However, not all outbreaks are investigated and reported and data from all systems may not be directly comparable (19,20).

Food handlers were identified as the contributing factor of nine norovirus outbreaks. This emphasizes the need for improved education and resources for food handlers and their employers and interventions to identify and exclude ill workers in a timely way.

Education and sanitizing the facility were the most commonly used interventions. Other interventions, such as recalls or policy changes are applied less often as they require identification of a specific food source or issue. Interventions are impacted by the setting they occur in, particularly those related to institutional settings where person-to-person transmission may be more common. However, it is not possible to comment on whether the interventions used were effective at preventing further cases as dates of the interventions were not available. Literature is limited regarding the effectiveness of outbreak interventions, particularly those that are widespread or community-based. Further investigation would assist decision-making, resource allocation and outbreak investigations.

While this analysis has demonstrated that the surveillance system is meeting its objectives there are limitations. The focus is on a small number of outbreaks which were reported over a short period of time. Therefore, more specific analysis by pathogen or by assessing trends over time is not possible. This limitation will be overcome eventually as more outbreaks are reported. In addition, the system relies on public health authorities to enter outbreaks in their jurisdiction. While processes have been established to

verify entry of known outbreaks, it is possible that not all outbreaks are identified, investigated and reported. Finally, decentralized data entry may also impact data quality. When data quality issues are identified, standards or system improvements are developed.

Conclusion

Surveillance of enteric disease outbreaks in BC provides information on trends, sources, settings and modes of transmission. These data have been used to inform technical and risk assessment, reports and publications. Further data and analysis could be used to inform local food safety priorities, develop messaging targeting pathogen-food combinations or direct resources at specific interventions.

Ongoing reporting and analysis of outbreak data in BC will allow for improved assessment of trends in sources and pathogens over time and further work to understand the effectiveness outbreak of interventions.

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Advisory Committee Statement

Summary of the Committee to Advise on Tropical Medicine and Travel (CATMAT) Statement on Travellers' Diarrhea

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Abstract

Background: Most travellers' diarrhea (TD) infections occur during travel to low- and middle-income countries. Type of travel, duration of stay, age of traveller and presence of certain medical conditions are important factors to consider for risk of TD. The Committee to Advise on Tropical Medicine and Travel (CATMAT) assembled a TD working group to develop recommendations on prevention and treatment of TD in travellers. This document is a summary of the *Statement on Travellers' Diarrhea*.

Methods: Following a systematic review of the literature, recommendations on the prevention and treatment of TD were developed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology to evaluate data quality, benefits and harms of the intervention, and values and preferences of the traveller. Other recommendations were based on a review of the literature and expert opinion.

Recommendations: Using the GRADE methodology, CATMAT concluded that oral cholera vaccine should not be routinely recommended to prevent TD in Canadian travellers. This recommendation was based on moderate quality data that showed this vaccine was not effective in preventing TD in travellers compared to placebo. Bismuth subsalicylate (BSS), fluoroquinolones or rifaximin are options for the prevention of TD based on high-quality data for BSS and fluoroquinolones and moderate evidence for rifaximin. For the treatment of TD, loperamide (alone or in combination with antibiotics), fluoroquinolones, azithromycin and rifaximin are all options, with varying degrees of data quality. Based on available evidence and expert opinion, CATMAT recommends handwashing or the use of hand sanitizer, as well as prudent choice and preparation of food and beverages as best practices for preventing diarrhea while travelling. At this time, a recommendation cannot be made for either the use of probiotics and prebiotics to prevent TD or the use of BSS to treat TD due to insufficient available evidence.

Conclusion: With the exception of BSS for prevention of TD (strong recommendation for use), CATMAT conditionally recommends the use of each of the other GRADE-evaluated preventive and therapeutic products assessed in this Statement. These CATMAT recommendations should be considered as options in the prevention and treatment of TD based on the particular situation of the traveller.

Preamble

The Committee to Advise on Tropical Medicine and Travel (CATMAT) provides the Public Health Agency of Canada with ongoing and timely medical, scientific, and public health advice relating to tropical infectious disease and health risks associated with international travel. The Agency acknowledges that the advice and recommendations set out in this Statement are based upon the best current available scientific knowledge and medical practices, and is disseminating this document for information purposes to both travellers and the medical community caring for travellers.

Persons administering or using drugs, vaccines or other products should also be aware of the contents of the product monograph(s) or other similarly approved standards or instructions for use. Recommendations for use and other information set out herein may differ from that set out in the product monograph(s) or other

similarly approved standards or instructions for use by the licensed manufacturer(s). Manufacturers have sought approval and provided evidence as to the safety and efficacy of their products only when used in accordance with the product monographs or other similarly approved standards or instructions for use.

Introduction

Travellers' diarrhea (TD) is defined as the passage of three or more unformed stools in a 24-hour period, usually accompanied by one or more symptoms of varying degrees of severity, such as nausea, vomiting, abdominal cramps, fever or blood in stools (1). The most commonly identified causes of TD are the bacterial pathogens *Escherichia coli* (particularly *enterotoxigenic and enteroaggregative*) and *Campylobacter* (2). TD is mainly acquired through the ingestion of food and beverages contaminated with pathogens which cause diarrhea. Most TD infections occur during travel to low- and middle-income countries (3). Type of travel, duration of stay, age of traveller and presence of certain medical conditions are important risk factors to consider for TD (4).

Incidence rates for TD for those travelling up to two weeks in high-risk regions (low- and middle-income countries) range from 20% to 90% (1). Up to half of travellers with TD will experience some limitation of activities during their trip (5,6), while up to 10% may develop complications such as persistent diarrhea or post-infectious irritable bowel syndrome (7).

Options for the prevention of TD include hand hygiene, food and beverage precautions, probiotics, vaccination, and chemoprophylaxis. Treatment of TD involves use of antisecretory, antimotility and/or antibiotic agents. Rehydration is also an important aspect of managing TD, particularly for children.
The Committee to Advise on Tropical Medicine and Travel (CATMAT) provides the Public Health Agency of Canada with ongoing and timely medical, scientific, and public health advice relating to tropical infectious disease and health risks associated with international travel. This is a summary of the CATMAT *Statement on Travellers' Diarrhea*; a full description of the evidence and recommendations is available (8).

Methods

This is the second CATMAT statement to use the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology to develop recommendations. GRADE is a method of grading the quality of the evidence and strength of recommendations in guidelines used by many international organizations (9). This process stresses transparency and provides an explicit framework in which the following factors are considered and weighed when making recommendations: confidence in the estimate of effect (quality of data); balance of benefits and harms; and values and preferences. Resulting recommendations are expressed as strong or conditional. See **Table 1** for the GRADE recommendation categories, as well as the Appendix below for frequently asked questions on how to interpret GRADE results.

Table 1: GRADE recommendation categories

GRADE recommendation categories[1]	
Strong[2]: Recommendation FOR	The Committee believes that all or almost all well-informed people would want the recommended course of action and only a small number would not. ***Implication for practitioners:*** The balance of risks and benefits are such that most travellers would choose the intervention.
Strong[2]: Recommendation AGAINST	The Committee believes that all or almost all well-informed people would **not** want the recommended course of action and only a small number would. ***Implication for practitioners:*** The balance of risks and benefits are such that most travellers would **not** choose the intervention.

Conditional[3]: Recommendation FOR	The Committee believes that the majority of well-informed people would want the recommended course of action, but a minority (perhaps a large minority) would not. ***Implication for practitioners:*** With a conditional recommendation different travellers may make different choices. Practitioners should present the risks and benefits of the intervention and help each traveller make a decision consistent with his/her values and preferences.
Conditional[3]: Recommendation AGAINST	The Committee believes that the majority of well-informed people would **not** want the recommended course of action, but a minority (perhaps a large minority) would. ***Implication for practitioners:*** With a conditional recommendation different travellers may make different choices. Practitioners should present the risks and benefits of the intervention and help each traveller make a decision consistent with his/her values and preferences.

[1]Adapted from the GRADE handbook and GRADE guidelines, section 14 and 15 (9–11).
[2]The GRADE working group suggests that if a recommendation is "strong," then it is expected that 90% or more of informed individuals would choose (or not choose) the recommended course of action.
[3]The GRADE working group suggests that if a recommendation is "conditional," then it is expected that less than 90% of informed individuals would choose (or not choose) the recommended course of action.

Literature search and identification

An analytic framework identifying key interventions for prevention and treatment of TD was developed. Key questions to define the magnitude of benefits and harms were identified as well as key "Population of interest, Intervention, Comparison and Outcome" (PICO) questions. The following four questions were used to frame the GRADE assessment and recommendations:

- Among Canadian travellers, does the administration of the inactivated oral cholera vaccine (Dukoral®) decrease the risk of acquiring TD as compared to no vaccine (placebo)?
- Among Canadian travellers, does the administration of a relevant *chemoprophylactic* agent (i.e., antisecretory or antibiotic) decrease the risk of acquiring TD as compared to no chemoprophylaxis (placebo)?
- Among Canadians having acquired TD during travel, does the administration of a relevant *therapeutic* agent (i.e., antisecretory, antimotility, or antibiotic) decrease the duration and/or severity of TD as compared to *no therapy* (placebo)?
- Among Canadians having acquired TD during travel, does the administration of a relevant *therapeutic* agent (i.e., antisecretory, antimotility, or antibiotic) decrease the duration and/or severity of TD as compared to an *alternative therapy* (e.g., addition of antimotility to antibiotic, different class of antibiotic)?

Certain interventions were not amenable to a GRADE assessment, either due to a lack of valid evidence or credible alternative interventions to which a comparison could be made. Questions were also developed to frame these non-GRADE recommendations related to antimicrobial resistance patterns, hygiene, food and water precautions, use of probiotics, prebiotics and synbiotics, and management of TD-related dehydration in travellers.

Several electronic databases (Ovid MEDLINE, Embase, Global Health and Scopus) and the Cochrane Review Database were searched using variations on the term "travellers' diarrhea" and the relevant search term(s) for each intervention of interest. The search spanned the initial date for each database up to June 1, 2013. For all searches, only articles in English and/or French were retained. Reference lists from relevant studies were also scanned to identify any studies not captured by the database searches.

In our analysis, TD was defined as three or more unformed stools with at least one enteric symptom within a 24-hour period. Studies that used a less restrictive definition of TD were excluded for consistency in

diagnostic criteria and to ensure a selection of the evidence focused on symptoms that would be of importance to most travellers and practitioners. For studies evaluating antibiotics and vaccine, those conducted in a non-traveller population were excluded. For antisecretory and antimotility studies, non-traveller populations were considered in situations where traveller data were scarce, but their inclusion in the analysis led to a rating down in the overall quality of evidence.

Assessment of evidence

Full details on GRADE methodology are described elsewhere (12). Briefly, the GRADE approach rates the quality of the evidence for specific clinical outcomes across studies, not study by study, by addressing flaws in methodology, consistency and generalizability of results and demonstrated effectiveness of the intervention (13, 14). The GRADE approach takes into consideration the balance of benefits (efficacy) and harms of each TD preventive and therapeutic intervention, the confidence in the estimates of effect for each intervention (high, moderate, low, or very low), and what are believed to be the values and preferences of the traveller. GRADE quality assessments of study results, including the efficacy and adverse effects associated with each intervention, were collated into evidence profile and summary of findings tables (8).

Recommendations were expressed as strong or conditional, as previously described (15). Other recommendations did not use the GRADE approach and were based on evaluation of the relevant literature and expert opinion.

Results

Prevention of TD

Oral cholera vaccine

Dukoral® is licensed in Canada for prevention of and protection against TD and/or cholera in adults and children 2 years of age and older who will be visiting areas where there is a high risk of contracting TD caused by *Enterotoxigenic Escherichia coli (ETEC)* or cholera caused by *V. cholera.*

Moderate quality data showed the oral cholera vaccine (Dukoral®) (16) to be not effective in preventing TD in travellers compared to vaccination with placebo (relative risk (RR)=0.94; 95% confidence interval (CI)=0.82−1.09) (17−19). Overall, 35% of vaccinated subjects and 37% of non-vaccinated subjects developed diarrhea. A systematic review also demonstrated no significant difference in efficacy between this vaccine and placebo for prevention of TD (20). There are no reported harms of the vaccine and there are no data on patient preference.

Certain short-term travellers at high risk for health complications or serious inconvenience from TD may find that the potential benefits of the vaccine, based on their personal values and preferences, coupled with a low likelihood of adverse events, outweigh the burden of their risk. As such, the following travellers may still be considered for Dukoral® vaccination:

- those for whom a brief illness cannot be tolerated (i.e., elite athletes, some business or political travellers)
- those with increased susceptibility to TD (e.g., due to achlorhydia, gastrectomy, history of repeated severe travellers' diarrhea, young children >2 years)
- those who are immunosuppressed due to HIV infection with depressed CD4 count or other immunodeficiency states
- those with chronic illnesses for whom there is an increased risk of serious consequences from TD (e.g., chronic renal failure, congestive heart failure, insulin dependent diabetes mellitus, inflammatory bowel disease)

It should be noted that consideration of these groups is based on expert opinion and that there are no published data on Dukoral® use in these specific groups.

Bismuth subsalicylate (BSS)

High-quality data showed BSS to be effective in preventing TD in travellers compared to placebo (RR=0.55; 95% CI=0.44–0.67) (21–23). This strong effect was similarly found when restricted to those receiving a high or low dosage of BSS, and no difference in effect was found when comparing high to low dosage. There are no reported serious harms for BSS and there are no data on patient preferences.

Prolonged use of BSS in children carries a risk of salicylate intoxication and bismuth encephalopathy, as well as a theoretical risk of Reye's syndrome (24). Use of BSS is permitted in the case of certain children aged 2 years and older, based on an individual assessment of risks and benefits. BSS use is not recommended in children younger than 2 years of age.

Fluoroquinolones

High-quality data showed fluoroquinolones to be effective in preventing TD in travellers compared to placebo (RR=0.12; 95% CI=0.07–0.21) (25–28). A systematic review also demonstrated a significant protective effect for fluoroquinolones in preventing TD (29). However, fluoroquinolone use in non-traveller populations has been associated with serious adverse events such as cartilage damage, arthropathies, tendon rupture and *C. difficile*-associated diarrhea (30–33). Fluoroquinolone use in travellers is also associated with a potential risk of selecting for antimicrobial resistant pathogens (34–39). A relatively high percentage of travellers surveyed in the sole descriptive study on traveller values and preferences indicated a preference against taking antibiotics for prevention of TD (40).

Rifaximin

Moderate quality data showed rifaximin to be effective in preventing TD in travellers compared to placebo (RR=0.42; 95% CI=0.33–0.53) (41–45). The quality of the evidence was downgraded for potential publication bias due to the fact that results were unavailable for one large study registered on the U.S. government's clinical trials database. Two recent systematic reviews also found a significant protective effect for rifaximin in preventing TD (29,46). There are no reported harms for rifaximin use. Although no associations between rifaximin use in travellers and antimicrobial resistance have been documented, potential risks will need to be monitored.

Treatment of TD

Loperamide

Loperamide was found to be effective in reducing the duration and intensity of TD in travellers compared to placebo (e.g., RR for first relief from acute diarrhea after four hours of treatment = 1.69; 95% CI=1.17–2.45) (47–52). The estimate of effect was rated down for indirectness since studies in non-traveller populations were used. Confidence in the estimate of effect was also lowered for three of the four outcomes due to an insufficient number of study subjects (imprecision). There are no reported harms for loperamide use.

A small study suggests an increase in adverse events with the use of diphenoxylate (Lomotil, an agent related to loperamide) for treatment of shigella infection (53). Lomotil has a less favourable side effect profile, and it has not been studied in the treatment of TD.

Loperamide use in travelling children has not been studied. However, one randomized controlled trial conducted in children aged 2 to 11 years with acute diarrhea found that loperamide treatment significantly reduced duration and severity with no difference between loperamide and placebo treatment groups with respect to drug-related adverse events (54). Dosages differ by age group and treatment should not exceed two days. Loperamide should not be administered to children less than 2 years of age (24). A high proportion of North American travellers surveyed stated a preference for treatment with antidiarrheals including loperamide (40).

Loperamide in combination with antibiotics

The addition of loperamide to antibiotic therapy was found to be effective in reducing the duration of TD in travellers when compared to antibiotic use alone (e.g., RR for complete relief from TD after 24 hours = 1.55; 95% CI=1.28−1.86) (48,55,56). Estimates of effect for two of the four outcomes were rated down to due to substantial variation between studies in the observed direction of effect (inconsistency). There are no reported harms for using loperamide in conjunction with antibiotics. A high proportion of North American travellers surveyed stated a preference for treatment with antidiarrheals including loperamide and antibiotics. Given the relatively mild nature of most episodes of TD, and the acceptable efficacy of antibiotics or loperamide alone, it is reasonable to reserve the combination of the two for treatment of severe diarrhea and/or when treatment with either antimotility or antibiotic alone is unsuccessful.

Fluoroquinolones

Moderate quality data showed fluoroquinolones to be effective in reducing the duration of TD in travellers compared to placebo (RR for cure after 72 hours of treatment = 1.81; 95% CI=1.39−2.37) (57,58). The estimate of effect was rated down due to imprecision. Fluoroquinolone use in non-traveller populations has also been associated with certain serious adverse events and potential risk of selecting for antimicrobial resistant pathogens. Children under the age of 18 should not be administered fluoroquinolones for treating TD unless the benefits are felt to outweigh the potential risks and other alternatives are not feasible.

Azithromycin

Data comparing azithromycin directly to fluoroquinolones (specifically, ciprofloxacin and levofloxacin) showed that for four outcomes of interest, azithromycin had an equivalent or greater efficacy in reducing the duration of TD in travellers compared to fluoroquinolones (e.g., RR for recovery after 48 hours of treatment = 1.34; 95% CI=1.08−1.66) (59−62). For the outcome of rapid or immediate cure from TD, fluoroquinolones demonstrated a greater reported efficacy than azithromycin (RR=0.46; 95% CI=0.25−0.84) (59,61). These results suggest that azithromycin's ability to provide relief from TD is equivalent to that of fluoroquinolones. The data were assessed as being of low quality and were rated down due to various factors including: insufficient number of events for certain outcomes (imprecision); variability in results between each study (inconsistency); and differences between studies in terms of dosages and use of loperamide as an adjunct therapy (indirectness). The evidence does not appear to indicate any serious harm associated with use of azithromycin, although low-quality data from two studies demonstrated a higher risk for nausea immediately after treatment with azithromycin (RR=6.23; 95% CI=1.48−26.26) (61,62). Otherwise, there were no differences between the two therapies in other measures of nausea and vomiting.

Rifaximin

High-quality data showed rifaximin to be associated with a higher percentage of travellers cured of TD compared to placebo (RR=1.29; 95% CI=1.15−1.45) (63,64). High-quality data from two studies comparing rifaximin directly to fluoroquinolones (ciprofloxacin) showed there was no significant difference between rifaximin and fluoroquinolones with respect to proportion cured of TD (64,65). There were no reported harms for rifaximin use. Although no associations between rifaximin use in travellers and antimicrobial resistance have been documented, potential risks will need to be monitored.

Non-GRADE interventions

Recommendations were made for hand hygiene or food and water precautions without using the GRADE approach since these are non-invasive, low-impact preventive interventions with no credible alternative intervention to which comparisons could be made. Based on available evidence and expert opinion, CATMAT recommends washing of hands or use of hand sanitizer, as well as prudent choice and preparation of food and beverages as best practices for preventing diarrhea while travelling. At this time, a recommendation cannot be made for either the use of probiotics and prebiotics to prevent TD or the use of BSS to treat TD due to insufficient available evidence. A more detailed discussion of the available literature on these subjects can be found in the full TD Statement (8).

Recommendations and conclusions

With the exception of BSS for prevention of TD (strong recommendation for use), CATMAT conditionally recommends the use of each of the other GRADE-evaluated preventive and therapeutic products assessed in this Statement (see **Table 2**). These recommendations are conditional due to: demonstrated weak effects, weakness in the evidence base for a given intervention, and/or the uncertain weight which should be accorded to potential harms of the intervention.

One of the potential harms lies in the use of antibiotics which may select for carriage of resistant pathogens by the host. This in turn could lead to an ill traveller being treated for TD (or another infection) with ineffective antibiotics. Although this risk has been well-demonstrated in other domains, there is no reliable evidence on the presence or magnitude of the risk in the case of TD. CATMAT recommends that more systematic surveillance and research be undertaken on resistance patterns of pathogens in the returned traveller who has taken a course of antibiotics to prevent or treat TD. This information will improve assessment of baseline risk for resistance based on destination and type of travel.

Although CATMAT had moderate confidence in the available evidence to conditionally recommend against routine use of the oral cholera vaccine Dukoral® for prevention of TD, further research evaluating the efficacy of this vaccine to prevent TD would be necessary to make a more definitive recommendation for or against its use in specific populations.

Table 2: GRADE recommendations on the prevention and treatment of travellers' diarrhea for Canadian travellers

GRADE recommendations	
Prevention of travellers' diarrhea	
CATMAT suggests	• Oral cholera vaccine (Dukoral®) not be routinely administered to Canadian traveller ***Conditional recommendation, moderate confidence in estimate of effect versus placebo.*** • Bismuth subsalicylate (BSS) be considered as an option for adults at significant risk, and who are willing to accept multiple doses per day (2.1g–4.2g/day, divided into four doses per day). ***Strong recommendation, high confidence in estimate of effect versus placebo.*** • Lower dosage (1.05g/day) of BSS could be used in situations where a higher dosage is not feasible. ***Conditional recommendation, low confidence in estimate of effect versus placebo, low confidence there is no difference in effect between high and low dosage.*** • Fluoroquinolones be considered as an option in select high-risk short-term traveller populations where chemoprophylaxis is considered essential. ***Conditional recommendation, high confidence in estimate of effect versus placebo. Balance of benefits and harms based on available evidence on adverse events and antimicrobial resistance patterns.*** • Rifaximin be considered as an option. ***Conditional recommendation, moderate confidence in estimate of effect versus placebo. Balance of benefits and harms based on available evidence on antimicrobial resistance patterns.***

Treatment of travellers' diarrhea	
CATMAT suggests	• Loperamide be considered as an option. ***Conditional recommendation, low to moderate confidence in estimate of effect compared to placebo.***
	• Fluoroquinolones be considered as an option. ***Conditional recommendation, moderate confidence in estimate of effect versus placebo. Balance of benefits and harms based on available evidence on adverse events and antimicrobial resistance patterns.***
	• Use of loperamide in conjunction with antibiotic therapy be considered as an option. ***Conditional recommendation, moderate to high confidence in estimate of effect compared to antibiotic use alone.***
	• Azithromycin be considered as an option. ***Conditional recommendation, low confidence in estimate of effect versus fluoroquinolone use. Balance of benefits and harms based on available evidence on antimicrobial resistance patterns and adverse events.***
	• Rifaximin be considered as an option. ***Conditional recommendation, high confidence in estimate of effect versus placebo, moderate to high confidence in estimate of effect versus ciprofloxacin. Balance of benefits and harms based on available evidence on antimicrobial resistance patterns.***
"Best practice" recommendations for prevention of travellers' diarrhea	
CATMAT suggests	• Handwashing with soap and water before preparing meals, before eating meals, and after urination or defecation. • Alcohol-based hand sanitizers may aid in reducing the risk of diarrheal illness among travellers. • Consumption of undercooked or raw meats and seafood (66,67) and unpasteurized eggs and dairy products (66) are best avoided. Foods cooked earlier in the day and not sufficiently reheated are also best avoided (68). • Consumption of fruits and vegetables that are difficult to clean (e.g., broad-leafed vegetables), or peel (69), or foods that are prepared, stored or served in unsanitary conditions (70) are best avoided. • Moist food items served at room temperature are best avoided (71). Dry items such as bread and rolls are safer to consume (72). • Bottled carbonated and alcoholic drinks may be relatively safe to drink while travelling. • Non-carbonated bottled water with intact seals can generally be assumed to be safe to drink. • Bringing water to a boil is the most effective way of producing potable water. • Water filtration should be followed by chemical disinfection (73).

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Conflict of interest

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Appendix: Frequently asked questions on how to interpret GRADE results

Question: How is the confidence in estimate of effect measured?

Answer: In the GRADE approach, study results are pooled together by outcome and an estimate of effect is determined using meta-analysis techniques. The quality of this evidence is then assessed based on five criteria:

- Risk of bias (i.e., limitations in the design and/or execution of the study)
- Imprecision (e.g., insufficient number of study subjects to detect effect)
- Inconsistency (i.e., too much variability in results between each study)
- Indirectness (e.g., important differences in how the outcome or intervention were measured across studies)
- Potential publication bias (i.e., studies with no effect or undesired effect were not published and therefore cannot be assessed in the analysis)

For each individual criterion not met, one must rate down the quality one point on the four-point scale, ranging from "high" to "very low." In addition, the reasoning behind each downgrade must always be noted.

Question: Does the confidence in the estimate of effect directly define the strength of a recommendation?

Answer: No. The strength of the recommendation is not only based on the estimate of effect but it also takes into account the nature of the risks and benefits, and the related values and preferences of the traveller.

Question: What does a "conditional" recommendation mean in practice?

Answer: GRADE-based recommendations in this Statement labelled "conditional" mean that CATMAT believes that the majority of well-informed travellers would choose the recommended course of action; however, a minority (perhaps a large minority) would not. This is either because the benefit of the intervention in question is modest, the confidence in estimate of effect is not high, or there are serious considerations for potential harm. An example of potential harm in the case of antibiotic use for TD prevention and treatment is the presence of antimicrobial resistance patterns.

Question: If one was to conclude through the GRADE process that there was a high level of confidence in the estimate of effect for Intervention A and a moderate level of confidence in the estimate of effect for Intervention B, does that mean that Intervention A is better or more effective than Intervention B?

Answer: No. The fact that these interventions have separate assessments of quality of evidence means by definition that they are being indirectly compared. If, for example, Intervention A is compared to placebo and Intervention B is compared to placebo, we cannot infer that A is better than B since this is an indirect comparison.

If, on the other hand, we are evaluating studies making a direct comparison between each intervention, we may make an assessment of preference for one intervention over the other. However, this will still depend on a global assessment of the estimate of effect and quality of evidence for each outcome of interest, not to mention specific needs of special groups such as children, values and preferences of travellers, etc. For the TD Statement, the only direct comparisons made between interventions for treatment of TD are: loperamide and antibiotic vs. antibiotic alone; azithromycin vs. fluoroquinolones; and rifaximin vs. fluoroquinolones.

Question: Why is some of the evidence assessed using GRADE in this Statement while other evidence is not?

Answer: CATMAT concluded that certain interventions were not amenable to the GRADE approach, either due to lack of credible alternatives to the intervention in question (e.g., handwashing for the prevention of TD) or an insufficient evidence base (e.g., food and beverage choice for the prevention of TD, use of probiotics for the prevention of TD). As such, CATMAT provided recommendations for these interventions based on a review of the literature and expert opinion.

Case Report

Ciguatera fish poisoning in an international ship crew in Saint John Canada: 2015

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Abstract

An international ship crew presented for medical care in Saint John, New Brunswick, following rapid onset of gastrointestinal and in some cases neurological and cardiac symptoms after a common fish meal. Ciguatera poisoning was identified as the cause of illness. This report describes the public health investigation and management of this incident, including collaboration between the implicated provincial and federal authorities.

Case presentation

On April 11, 2015, nine male crew members of an international cargo vessel docked in Saint John, New Brunswick (NB) presented to the emergency department at the Saint John Regional Hospital (SJRH) with gastrointestinal symptoms (nausea, vomiting, diarrhea and abdominal cramps). Other significant symptoms included dizziness, weakness and peripheral extremity paresthesia. When examined, several of the men were further found to have hypotension and bradycardia. All were admitted for intensive care-level monitoring and management, including continuous cardiac monitoring, atropine for bradycardia, antiemetics and intravenous rehydration. Within a few hours, five more crew members presented with the same symptoms and were also admitted.

The crew members reported that they had consumed a common meal of fish stew using fish they had caught during their voyage in the Caribbean and had begun feeling ill 1-1.5 hours afterwards. The attending physicians consulted with the regional poison centre in Halifax and identified ciguatera fish poisoning as the most likely diagnosis. The incident was reported to the public health department.

Involved agencies

This situation required a response from both federal and provincial public health services as well as the local regional health authority (RHA). Clarity regarding the respective roles of each agency was key to ensuring that timely public health actions were implemented and that organizational mandates were respected.

The Travelling Public Program (TPP) of the Public Health Agency of Canada (PHAC) responded to this enteric disease outbreak as part of their mandate to ensure sanitation standards on public conveyances (in this case, an international conveyance in Canadian waters) (1). The TPP is also responsible for administering the Ship Sanitation Certificate Program (as per the World Health Organization's International Health Regulations). The PHAC Quarantine Program was not activated as it was determined that the crew had not contracted a communicable illness as defined in the federal Quarantine Act.

The Health Protection Branch of the Office of the Chief Medical Officer of Health (NB Department of Health) also became involved because a notifiable event had been reported by clinical staff at the SJRH, as is required under the NB *Public Health Act* (2) and associated regulations (3).

The Emergency Preparedness and Response Branch (NB Department of Health) provided coordination support between impacted provincial health system agencies. Clinical and emergency incident management support was provided by Ambulance New Brunswick and various staff of the SJRH, Horizon Health Network. Laboratory support was provided by the Canadian Food Inspection Agency (CFIA) food chemistry laboratory in Dartmouth, Nova Scotia.

Investigation and methods

NB clinicians are required to report clusters of illness thought to be food- or water-borne verbally within one hour to their regional public health office. They are also required to report unusual illness (not expected to occur in NB or unknown etiology) within 24 hours. The on-call public health staff (public health inspector and the medical officer of health) liaised with the SJRH staff to collect initial information on the clinical status and probable diagnosis of the affected crew. Control measures included closure of the ship's galley kitchen, monitoring of remaining crew members, obtaining regular clinical updates on hospitalized crew members and liaising with federal counterparts regarding the inspection of the galley kitchen and remaining food.

TPP Environmental Health Officers were dispatched on April 12, 2015 to conduct an inspection of the ship's food preparation and storage area, provide food safety advice, collect food samples and dispose of any potentially contaminated food products. Samples of fish left over from the suspect meal and samples of frozen fish that were also caught in the Caribbean were sent to the CFIA laboratory (Dartmouth) for species analysis and toxin testing.

Initial interviews of the discharged affected crew using a standardized enteric illness questionnaire were conducted on April 14, 2015. A letter to crew members, outlining the cause and prevention of ciguatera fish poisoning as well as prognosis and post-illness advice was also distributed to the crew on April 14, 2015. A final interview of the affected crew members was conducted jointly by federal and provincial investigative staff on April 17, 2015. Medical records for all hospitalized crew members were obtained from Horizon Health Network and reviewed for further information on clinical presentation and course in hospital.

Results

There were 19 crew members onboard the cargo vessel when the outbreak occurred, of which fourteen (73.7%) had eaten the suspect meal of fish soup. The five remaining crew were either sleeping or ate the alternative pork meal that was served. All crew that ate the fish meal were ill and required admission to hospital for intensive care-level monitoring and management. A Code Orange (mass casualty event) was initiated by the SJRH to manage this large influx of critically ill patients.

The galley kitchen was closed until a full inspection was conducted and the remaining crew obtained food off-ship during that time. Remaining crew members were monitored for approximately 12 hours until it could be firmly established that there were no remaining individuals who were susceptible.

The average length of hospital stay for those affected was 3.5 days and one individual required a readmission for continued symptoms. Following discharge, the crew members were repatriated by the ship owners as several of them were considered to be "unfit for duty" by attending physicians.

The severity of symptoms directly correlated with the amount of fish soup that was consumed and what part of the fish was ingested. For example, the individual who experienced the most severe symptoms ate the largest portion of the meal including the head of the fish.

Further questioning revealed that the crew had line fished off the boat while anchored in the Bahamas and had caught more than 125 kilos of fish in this manner. The fish was separated and frozen intact for crew

consumption and portions were eaten daily during their voyage north to Saint John, NB. While at the port in Saint John one of the larger fish was thawed then prepared by removing entrails, gills, and fins, descaled, and then cooked in a fish soup with the head still attached.

The fish stew specimen was reported as 'suspected positive' for ciguatoxin (due to lack of analytical standards the lab was unable to quantify the concentration of ciguatoxin in the sample). The remaining fish on the ship that was unlabelled or obtained from an unapproved food supplier was soaked in a strong sodium hypochlorite solution to render it inconsumable and then disposed.

Discussion

Ciguatera is a foodborne illness that is caused by eating reef fish contaminated with a toxin called "ciguatoxin". Ciguatoxin is colorless, odorless and tasteless and the fish are not altered in appearance. The toxin cannot be destroyed by cooking, smoking, freezing, canning, salting or drying. This poison is produced by dinoflagellates, small organisms that attach to algae growing in warm ocean reef areas. Small plant eating fish ingest these toxic algae and are then eaten by larger predatory fish, which are in turn consumed by humans (4). Fish in affected areas are not uniformly impacted, so it is possible for only a few fish out of any given catch to contain sufficient levels of toxin to cause illness. The toxin is lipid-soluble and concentrates in the head, viscera and roe of the fish (5). The public health system played an important role in conveying this information to the crew (and by extension to their superiors) in order to better understand the cause of the situation and how to prevent it in the future, thus providing an important complement to clinical discharge advice.

Symptoms of ciguatera fish poisoning can occur within minutes, but generally develop within 24 hours of eating contaminated fish. Initial gastrointestinal symptoms include nausea, vomiting, diarrhea and abdominal pain. These symptoms may last several days. Neurological symptoms develop after the initial gastrointestinal symptoms, and include tingling and numbness around the mouth, lips, throat, arms and legs, sore muscles and tooth pain, temperature reversal (hot things feel cold and cold things feel hot), feeling tired, headaches and itchy skin. In severe cases, neurological symptoms can last months or longer and may be worsened by changes in dietary behavior (such as dieting or high protein meals), alcohol consumption, exercise or sexual intercourse (5). Initial clinical information and ongoing monitoring of the hospitalizations were an important aspect of the public health assessment, however there were key discrepancies noted in the information received (such as a lack of reporting of neurological symptoms and absence of routine stool testing) that prompted subsequent medical chart review. While acknowledging the challenge of multiple clinician involvement, clear communication of public health needs, via direct public health physician to clinical physician contact would help to ensure that public health considerations are integrated with clinical management.

Diagnosis is based on astute recognition of the clinical presentation and compatible food exposure history. No human diagnostic testing is currently available. However, stool specimens should be routinely collected to rule out other more common causes of foodborne intoxications. If food specimens are available they can be collected and tested for presence of ciguatera toxin. There is no antidote for ciguatera poisoning, and people who have consumed ciguatoxin receive symptomatic treatment (6). Most people suffering from ciguatera fish poisoning will recover completely within a few days or weeks, but in very rare cases, ciguatera can be fatal (4).

This outbreak investigation presented an important learning opportunity regarding inter-agency dynamics and communication. Perhaps the most significant issue was early overlap regarding the relative roles of the federal and provincial agencies in the assessment and initial response to this situation. This was due in part to the fact that the federal and provincial agencies were notified through two separate processes – in the case of the TPP, by notification from Quarantine Services (who liaise with port authorities) and in the case of the Health Protection Branch office, by the hospital receiving the patients. This caused some initial duplication, but when we reviewed this afterwards, we decided not to change any processes as we concluded that it was better to have some redundancies in the system rather than a potential gap. We also concluded that the maintenance of ongoing relationships and links between agencies is critical to ensure that

roles and responsibilities are clear during a response. When incidents occur out of regular business hours, direct communication is particularly helpful to those who may be cross-covering other responsibility areas.

Recent research has suggested that climate change could increase the burden of ciguatera fish poisoning by expanding the range of suitable warm water habitats (7). However, it is also possible that if sea surface temperatures get too high, ciguatera toxin production by dinoflagellates could decrease. (8) In the meantime, prevention relies on public and industry awareness of ciguatera-affected areas and fish species (in particular, requiring that food for international shipping crews be obtained only from approved sources), since ciguatera toxic fish are not easily detected and no known preparation method can remove or destroy the toxin.

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ID News: Gastrointestinal therapies

Freedman SB, Pasichnyk D, Black KJ, Fitzpatrick E, Gouin S, Milne A, et al. **Gastroenteritis Therapies in Developed Countries: Systematic Review and Meta-Analysis.** PLoS One. 2015 Jun 15;10(6):e0128754. doi: 10.1371/journal.pone.0128754.

CONTEXT: Gastroenteritis remains a leading cause of childhood morbidity.

OBJECTIVE: Because prior reviews have focused on isolated symptoms and studies conducted in developing countries, this study focused on interventions commonly considered for use in developed countries. Intervention specific, patient-centered outcomes were selected.

DATA SOURCES: MEDLINE, EMBASE, the *Cochrane Database of Systematic Reviews*, trial registries, grey literature, and scientific meetings.

STUDY SELECTION: Randomized controlled trials, conducted in developed countries, of children aged <18 years, with gastroenteritis, performed in emergency department or outpatient settings which evaluated oral rehydration therapy (ORT), antiemetics, probiotics or intravenous fluid administration rate.

DATA EXTRACTION: The study was conducted in accordance with the *Cochrane Handbook for Systematic Reviews of Interventions* and the PRISMA guidelines. Data were independently extracted by multiple investigators. Analyses employed random effects models.

RESULTS: Thirty one trials (4,444 patients) were included. ORT: Compared with intravenous rehydration, hospitalization (RR 0.80, 95%CI 0.24, 2.71) and emergency department return visits (RR 0.86, 95%CI 0.39, 1.89) were similar. Antiemetics: Fewer children administered an antiemetic required intravenous rehydration (RR 0.40, 95%CI 0.26, 0.60). While the data could not be meta-analyzed, three studies reported that ondansetron administration does increase the frequency of diarrhea. Probiotics: No studies reported on the primary outcome, three studies evaluated hospitalization within 7 days (RR 0.87, 95%CI 0.25, 2.98). Rehydration: No difference in length of stay was identified for rapid vs. standard intravenous or nasogastric rehydration. A single study found that 5% dextrose in normal saline reduced hospitalizations compared with normal saline alone (RR 0.70, 95% CI 0.53, 0.92).

CONCLUSIONS: There is a paucity of patient-centered outcome evidence to support many interventions. Since ORT is a low-cost, non-invasive intervention, it should continue to be used. Routine probiotic use cannot be endorsed at this time in outpatient children with gastroenteritis. Despite some evidence that ondansetron administration increases diarrhea frequency, emergency department use leads to reductions in intravenous rehydration and hospitalization. No benefits were associated with ondansetron use following emergency department discharge.